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Asthma Morbidity, Comorbidities, and Modifiable Factors Among Older Adults

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Abstract

Background—Asthma morbidity is increased among older adults, especially older adult women. Interventions to improve asthma control in this population are not well-described.

Objective—Identify risk factors (including modifiable factors) associated with asthma-related hospitalizations and emergency department or urgent care center visits (ED/UCV) among older adults. A secondary objective was to investigate sex differences in variables relevant to asthma control.

Methods—Data were obtained from 14,076 older adults ≥65 years with active asthma participating in the 2006–2010 Behavioral Risk Factor Surveillance System Asthma Call-back Survey (a random-digit dialed survey) in 40 U.S. states, the District of Columbia, and Puerto Rico, representative of >2.6 million persons. Weighted, adjusted logistic regression was conducted.

Results—≥1 asthma-related hospitalizations in the past year were reported by 5.7% (95% confidence interval [95% CI]=5.0–6.4%) of participants; 10.6% (95% CI=9.7–11.5%) reported ≥1 asthma-related ED/UCV. Compared to older adults without asthma-related hospitalizations, adjusted odds were higher among those with ≥1 asthma-related hospitalization for chronic obstructive pulmonary disease (COPD), coronary artery disease, depression, cockroaches or mold in the home, and cost barriers to asthma-related health care or medication. All these factors, except for cockroaches, were associated with asthma-related ED/UCV. Compared to males, adjusted odds were higher among females for COPD, depression, obesity, and cost barriers to asthma-related health care or medication.

Conclusions—Among older adults, asthma-related hospitalizations and ED/UCV were associated with clinical comorbidities, mold in the home, and financial barriers to asthma-related health care. Interventions addressing modifiable factors could reduce asthma morbidity among older adults.

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Keywords

asthma; older adults; elderly; health care utilization; environment; cockroach; mold; cost; chronic obstructive pulmonary disease; depression

INTRODUCTION

The number of older adults is rapidly growing worldwide.[1, 2] In the United States alone, the number of U.S. adults aged ≥65 years (hereafter referred to as “older adults”) will more than double by 2030 to approximately 71 million.[2] Although the prevalence of asthma in this age group is comparable to that of the general adult population,[3] data on asthma-related hospitalizations and deaths indicate asthma morbidity and mortality are higher among older adults.[1, 4–7] The burden of asthma is especially high among older adult women.[7]

Asthma among older adults is a topic under active investigation, and many unanswered questions remain.[1, 8] Targeted interventions to improve asthma control and decrease asthma burden in this population are not well-described. Limited data exist on barriers to adherence and other potentially modifiable factors related to asthma morbidity among older adults (for example, environment factors).[1, 8–10]

This study analyzed 2006–2010 data on older adults in 40 U.S. states, the District of Columbia, and Puerto Rico to identify risk factors associated with asthma-related hospitalizations, with a focus on potentially modifiable factors. Another indicator of morbidity — risk factors associated with asthma-related emergency department or urgent care center visits (ED/UCV), including potentially modifiable factors — was also examined. Lastly, because female sex is a known risk factor for increased asthma morbidity among older adults[7], secondary analyses explored how this disparity might be related to sex differences in other variables relevant to asthma control.

METHODS

Asthma Call-back Survey

Data were analyzed from the 2006–2010 Behavioral Risk Factor Surveillance System (BRFSS) and the BRFSS Adult Asthma Call-back Survey (ACBS).[11, 12] BRFSS is an ongoing, state-based, random-digit-dialed telephone survey of non-institutionalized U.S. adults aged ≥18 years.[11] Before 2011, BRFSS interviews were conducted by landline telephone.[11] Detailed information about BRFSS’ multistage sampling design and sample weighting is available elsewhere.[11] ACBS is a follow-up telephone survey administered to BRFSS participants who indicated that they ever had asthma (i.e., they responded ‘yes’ to the question, “have you ever been told by a doctor, nurse, or other health professional that you had asthma?”).[13] ACBS is conducted approximately two weeks after BRFSS.[13] Jurisdiction-specific Institutional Review Board (IRB) requirements apply to each participating state, territory, and the District of Columbia; informed consent was obtained.[13] Analyses of BRFSS and ACBS data are exempt from review by the IRB at the Centers for Disease Control and Prevention.

To obtain a sufficiently large sample to produce stable estimates, Adult BRFSS and ACBS data were combined from 2006–2010.[13] Data were weighted to represent adults aged ≥18 years with asthma from 40 states, the District of Columbia, and Puerto Rico (i.e., U.S. areas from which Adult BRFSS and ACBS data were available during 2006–2010).[12] Additional information on participating states, weight calculations, and response rates is located online and in prior publications.[12, 14, 15]

Study Sample

This study was focused on adults aged ≥65 years with active asthma (Figure 1). As in previous analyses of BRFSS and ACBS data,[16–18] respondents were classified as having active asthma if they reported in ACBS that at least one of the following occurred during the past 12 months: talked to a doctor or other health professional about his or her asthma, took asthma medication, or experienced any symptoms of asthma.

For background information, the study population of adults aged ≥65 years with active asthma was compared to adults aged 18–64 years with active asthma (Online Repository Table E1). The same definition for active asthma was applied to both groups.

BRFSS Variables

Respondent characteristics obtained from BRFSS data were age (at time of interview), sex, race/ethnicity, U.S. census region, annual household income, and smoking history. Smoking history was assessed using responses to the questionnaire item, “Have you smoked at least 100 cigarettes in your entire life?”

Clinical comorbidity information regarding coronary artery disease (CAD), diabetes, and obesity were obtained from BRFSS data. Respondents were classified with CAD if they answered “yes” to ≥1 of the following two questionnaire items: “Has a doctor, nurse, or other health professional ever told you that you had a heart attack, also called a myocardial infarction?” or “Has a doctor, nurse, or other health professional ever told you that you had angina or coronary heart disease?” History of diabetes was determined using the questionnaire item “Has a doctor, nurse, or other health professional ever told you that you had diabetes?” Gestational diabetes, prediabetes, and borderline diabetes were not included in the definition of diabetes for this analysis. Individuals with a body mass index (BMI) ≥30 kg/m^2 calculated from their reported height and weight were categorized as obese.

ACBS Variables

Characteristics obtained from ACBS responses included time since asthma diagnosis and asthma medication use in the past three months. Time since asthma diagnosis was determined from the questionnaire item, “How long ago was it [when you were first told by a doctor or other health professional that you had asthma]?” Asthma medication use in the past three months was classified into four categories: none, short-acting β agonist (SABA) only, ≥1 asthma controller medication (i.e., inhaled corticosteroids, long-acting β agonists, leukotriene modifiers, methylxanthines, cromolyn, nedocromil, or immunomodulators), and oral corticosteroid only (without SABA or asthma controller medication[s]).

Asthma control was assessed using previously published methods that were adapted from the 2007 National Asthma Education and Prevention Program Guidelines for the Diagnosis and Management of Asthma (EPR-3) and account for the ACBS design (Table E2).[14, 19, 20] Briefly, three impairment measures were assessed: daytime symptoms, night-time symptoms, and SABA use (other than for preventing exercise-induced bronchospasm) during the past three months. Asthma control was defined using the highest impairment level identified for each adult across these three measures.

Asthma severity was measured according to EPR-3 guidelines and previously published methods, which classified asthma severity using information on asthma control and controller medication use.[15, 19, 20] Briefly, respondents whose asthma was well controlled without asthma controller medication use in the past three months were categorized as having intermittent asthma. Persistent asthma included all respondents who reported using asthma controller medication (regardless of asthma control status) and respondents not reporting asthma controller medication use but meeting criteria for not well controlled or very poorly controlled asthma. Additional information on defining asthma control and severity using ACBS data is available in prior publications.[14, 15, 20]

Information on asthma-related hospitalizations was obtained from the questionnaire item, “During the past 12 months, that is since [1 year ago today], have you had to stay overnight in a hospital because of your asthma? Do not include an overnight stay in the emergency room.” Information on asthma-related ED/UCV was obtained from the questionnaire item, “During the past 12 months, have you had to visit an emergency room or urgent care center because of your asthma?”

Regarding clinical comorbidities, ACBS data were used to identify respondents with a history of chronic obstructive pulmonary disease (COPD) or depression. Respondents were classified with COPD if they answered “yes” to ≥1 of the following three questionnaire items: “Have you ever been told by a doctor or health professional that you have chronic obstructive pulmonary disease, also known as COPD?”, “Have you ever been told by a doctor or other health professional that you have emphysema?”, or “Have you ever been told by a doctor or other health professional that you have chronic bronchitis?” History of depression was determined using the questionnaire item “Have you ever been told by a doctor or other health professional that you were depressed?”

Regarding potentially modifiable factors, cost as a barrier to health care was investigated using questionnaire responses concerning inability to buy medication, see a primary care physician, or see a specialist for asthma in the past 12 months. Home environment variables were related to secondhand smoke, pets allowed in respondents’ bedrooms, reports of seeing or smelling mold in the home in the past 30 days, and report of seeing cockroaches, mice, or rats inside the home in the past 30 days.

As in previous analyses, uninformative responses (i.e., don’t know, missing, refused) were considered negative responses (i.e., not having the relevant outcome).[16, 18, 20, 21]

Statistical Analysis

Sampling weights were used to calculate population estimates representative of 40 states, the District of Columbia, and Puerto Rico (Table E2). These sampling weights accounted for BRFSS and ACBS nonresponse and unequal sampling probabilities.[17] To properly account for the complex sample survey design, the entire dataset (N = 74,209 ever diagnosed with asthma) was retained in the final analyses. Given this investigation's focus on adults aged ≥65 years with active asthma, only results generated from the stratum of the population of 14,076 older adults with active asthma (Figure 1) are presented in the main tables.

Complex sample survey procedures were used to compare continuous and categorical variables (PROC SURVEYMEANS and PROC SURVEYFREQ in SAS, respectively).[22, 23] Multivariate logistic regression was performed to calculate odds ratios and 95% confidence intervals (CIs) for associations between asthma-related hospitalizations or ED/UCV and all variables of interest; results were adjusted for sex, race/ethnicity, annual household income, smoking history, and asthma severity. Statistical significance was set at a P value <0.05. Results based on <50 unweighted respondents (i.e., percentages based upon a denominator <50) or for which the relative standard error (standard error/prevalence estimate; a measure of an estimate's reliability) was >0.3 were suppressed.[12] Identical procedures were used in secondary analyses examining potential sex differences in variables relevant to asthma control, as well as sensitivity analyses (stratification by COPD status; modified active asthma definition using a 3-month time frame for asthma medication use instead of the conventional 12-month time frame). These analyses were conducted in SAS version 9.3 (SAS Institute Inc., Cary, NC).

Population attributable fractions (PAFs) were calculated using the formula PAF = (p[RR-1])/(p[RR-1]+1), where RR is the relative risk and p is the proportion of the study population with the risk factor; RR was estimated by the adjusted OR. Similarly, PAF 95% CIs were estimated using adjusted OR 95% CIs.

RESULTS

In this study, 14,076 unique older adults (≥65 years) with active asthma were identified (Figure 1). Because sampling weights were incorporated into these analyses, this study population represents over 2.6 million older adults. Of this study population, 5.7% (95% CI=5.0–6.4%) reported ≥1 asthma-related hospitalization and 31.9% (95% CI=30.1–33.5%) reported ≥1 asthma-related ED/UCV in the past year. Compared to adults aged 18–64 years, older adults were more likely to have asthma-related hospitalizations, very poorly controlled asthma, persistent asthma, and medication regimens with ≥1 asthma controller (Table E1). Asthma-related ED/UCV and work-related asthma diagnosed by a health professional were less common among older adults.

Asthma-Related Hospitalizations Among Older Adults

The percentage of older adults with ≥1 asthma-related hospitalization varied significantly by geographic region (P=.03; Table I). Compared to older adults with no asthma-related hospitalizations in the past year, those with ≥1 asthma-related hospitalization were more

likely to be Black, female, and report annual household incomes <$25,000. Additional demographic information is presented in Figure E1. Persistent asthma, very poorly controlled asthma, and use asthma controller medication was more common among older adults with ≥1 asthma-related hospitalization. The two groups did not differ significantly in smoking history (*P*=.06) or age (weighted average ± standard error=73.1±0.5 years for ≥1 asthma-related hospitalization vs. 73.4±0.1 years for no asthma-related hospitalizations, *P*=.5).

In multivariate analyses (Table II), asthma-related hospitalizations among older adults were associated with COPD, CAD, depression, and diabetes, but not obesity. Compared to older adults without asthma-related hospitalizations, adjusted odds were higher among older adults with asthma-related hospitalization(s) for being unable to see a primary care doctor for asthma, see a specialist for asthma, or buy medication for asthma because of cost. Also, signs of mold or cockroaches in the home were associated with asthma-related hospitalizations. Estimates of PAFs (Table E3) indicated the variable with the largest overall PAF was COPD (0.63; 95% CI=0.50–0.73); of modifiable factors examined, the largest PAF was associated with financial barriers to buying asthma medication (0.14; 95% CI=0.08–0.21).

Asthma-Related Emergency Department or Urgent Care Center Visits (ED/UCV) Among Older Adults

Factors associated with asthma-related ED/UCV were similar to those for hospitalizations (Table III). COPD, CAD, depression, and diabetes were more common among older adults with ≥1 asthma-related ED/UCV, as were the inability to see a primary care doctor for asthma, see a specialist for asthma, or buy medication for asthma because of cost. Compared to older adults without asthma-related ED/UCV, adjusted odds were higher among older adults with asthma-related ED/UCV for signs of mold in the home. In contrast to asthma-related hospitalizations, asthma-related ED/UCV were not significantly associated with cockroaches in the home.

Sensitivity Analyses

A sensitivity analysis of older adults with asthma but not COPD (n = 7,725) indicated financial barriers to asthma-related health care were significantly associated with asthma-related hospitalizations, but clinical comorbidities and home environment conditions were not (Table E4). In this population, obesity was the only variable examined that was found to be associated with asthma-related ED/UCV. Among older adults with both asthma and COPD (n = 6,351), CAD and financial barriers to asthma-related health care were significantly associated with asthma-related hospitalizations; besides these variables, depression was also associated with asthma-related ED/UCV in this population. Results from a sensitivity analysis using a modified definition of active asthma yielded results similar to the main analyses (Table E5), except diabetes and home environment conditions were not significantly associated with asthma-related hospitalizations or ED/UCV.

Sex Differences Among Older Adults

Compared to older men with active asthma, older women with active asthma were more likely to be Black and report annual household incomes <$25,000 (Table E6). The frequency of well controlled asthma was similar among men and women (40.2% [95% CI=37.2–43.2%] vs. 39.0% [95% CI=37.2–40.9%], respectively). Not well controlled asthma was more common among women (28.2% [95% CI=26.5–29.8%], compared to 23.5% [95% CI=21.0–26.0%] among men). In contrast, very poorly controlled asthma was more common among men (36.3% [95% CI=33.3–39.3%], compared to 32.8% [95% CI=31.1–34.5%] among women). Asthma medication use, asthma severity, and (weighted) average age did not differ significantly by sex. Men were more likely than women to report a lifetime smoking history of ≥100 cigarettes.

Compared to male older adults, adjusted odds were higher among female older adults for COPD, depression, and obesity (Table E7). In contrast, adjusted odds were lower among female older adults for CAD. Female sex among older adults was associated with being unable to see a primary care doctor for asthma or buy medication for asthma because of cost. No sex differences in home environment variables were observed.

DISCUSSION

In a survey of older adults with active asthma from 40 U.S. states, the District of Columbia, and Puerto Rico, multivariate analyses revealed that clinical comorbidities, financial barriers to care, and selected home environment conditions were significantly associated with asthma-related hospitalizations or ED/UCV. This investigation identified new associations between asthma morbidity and several potentially modifiable factors among older adults. These findings are representative of >2.6 million older adults with active asthma. This study population is one of the largest samples of older adults with asthma to date.

For clinicians caring for this population in the acute or chronic setting, asthma-related hospitalizations or ED/UCV might prove helpful for identifying older adults with asthma who could benefit from an assessment of their need for home mold remediation, case management, integrated pest management (for asthma-related hospitalizations), or other interventions recommended by the EPR-3.[19, 25] These findings could also be useful in informing public health or health care delivery. The associations between financial barriers to care and asthma morbidity identified herein are also notable because similar associations have been previously reported for older adults with other chronic conditions (COPD, cancer, cardiac disease) but had not yet been reported for asthma.[7]

This study's findings regarding clinical comorbidities associated with asthma-related hospitalizations and ED/UCV support and extend prior literature. Individuals with both asthma and COPD (i.e., overlap) typically experience more frequent and severe exacerbations of these conditions.[26] Depression has been associated with presence of asthma and worse asthma control among older adults; these results indicate asthma-related hospitalizations and ED/UCV are additional concerns for older adults with concomitant asthma and depression.[1, 7, 27] Prior studies have reported heart disease and diabetes to be more prevalent among adults with asthma compared to adult controls[1, 27–29], but older adults

comprised a minority in these study populations and asthma-related hospitalizations or ED/UCV were not examined.[28, 29]

Current evidence suggests obesity is a risk factor for development of asthma and can affect asthma control[30, 31], but very little is known about the relationship between obesity and asthma in older adults.[32] Higher BMI was associated with current asthma in a Korean study of adults aged ≥65 years, but few participants were classified with current asthma (5.4%).[32] An analysis of 2006–2010 Medical Expenditure Panel Survey data on adults aged ≥65 years found obesity to be a significant predictor of asthma-related costs (including inpatient, outpatient, emergency department, and prescription costs).[33] Further specificity regarding the relationship between obesity and costs in selected settings (e.g., inpatient vs. outpatient) was not reported.[33] Given the present study's findings that obesity was not significantly related to asthma-related hospitalizations or ED/UCV, these previously reported, obesity-related medical expenditures among older adults with asthma might be attributable to medical claims other than hospitalizations or ED/UCV.

Our secondary analysis of sex differences in demographic, clinical, and potentially modifiable characteristics support and expand current understanding of how these factors could relate to the disproportionately high burden of asthma among older women compared to older men.[4,7] Concomitant asthma and COPD has been associated with female sex;[34] depression and obesity have been identified as comorbidities of particular concern among older women.[7] Poverty is more common among older women than older men, and this study is the first to directly link female sex to cost barriers in buying asthma medication or seeing a primary care doctor for asthma among older adults. Frequently, the causes of nonadherence are multifactorial[7]; nevertheless, these results strengthen the evidence for how poverty can contribute to sex differences in asthma burden among older adults.

Several limitations might affect interpretation of results reported herein. Survey data were cross-sectional, so causality cannot be inferred and temporal proximity between asthma-related health care utilization and other variables could not be assessed. Survey design limited how variables could be defined, such as smoking history, depression, and asthma control. These findings cannot be generalized to older adults in the 10 states not included in this dataset or those without household access to landline telephones. Non-response bias was possible, but sampling and weighting procedures helped diminish the potential impact on results. Collider bias[24, 35] might have affected our results regarding relationships between health care access (e.g., cost as a barrier to seeing a doctor for asthma) and asthma-related hospitalizations or ED/UCV, because the selection of individuals with active asthma was partially predicated on potentially overlapping attributes (e.g., talked to a doctor or other health professional about asthma in the past 12 months).[16–18] The content of the BRFSS and ACBS questionnaires limited investigation of other potential contributors to asthma morbidity and precluded distinguishing between emergency department and urgent care center visits. Data on IgE sensitization were not collected. Furthermore, self-reported diagnoses of asthma and clinical comorbidities could not be confirmed through medical chart review or other means. Lastly, an important caveat for interpreting PAF results was that the unit of analysis in the dataset was persons rather than episodes of health care utilization.

In conclusion, this study analyzed data on older adults with active asthma from 40 U.S. states, the District of Columbia, and Puerto Rico and found multiple risk factors, including potentially modifiable factors (financial barriers to asthma-related health care, home environment), to be significantly associated with asthma-related hospitalizations or ED/UCV. A secondary analysis revealed sex-related cost barriers to asthma-related health care that could be related to the previously reported higher burden of asthma among older women compared to older men. Together, these findings advance understanding of asthma among older adults and highlight potential opportunities to reduce asthma morbidity. Further investigation into targeted interventions for older adults with asthma could establish how to most effectively improve asthma control and reduce asthma disparities in this growing population.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

The findings and conclusions in this article are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

Abbreviations used

ACBS	Asthma Call-back Survey
BMI	body mass index
BRFSS	Behavioral Risk Factor Surveillance System
CAD	coronary artery disease
CI	confidence interval
COPD	chronic obstructive pulmonary disease
ED/UCV	asthma-related emergency department or urgent care center visits
EPR-3	2007 National Asthma Education and Prevention Program Guidelines for the Diagnosis and Management of Asthma
IRB	Institutional Review Board
PAF	population attributable fraction
RR	relative risk
SABA	short-acting β agonist

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Highlights box

1. ***What is already known about this topic?*** Asthma morbidity is increased among older adults, especially older adult women.
2. ***What does this article add to our knowledge?*** Multivariate analyses of survey data (representative of 40 states, Washington, DC, and Puerto Rico) found associations between urgent asthma-related health care utilization by older adults and health care access, mold in the home, and comorbidities.
3. ***How does this study impact current management guidelines?*** Urgent asthma-related health care utilization by older adults could represent opportunities to improve asthma control through interventions addressing modifiable factors (e.g., case management, assessment or remediation of the home environment).

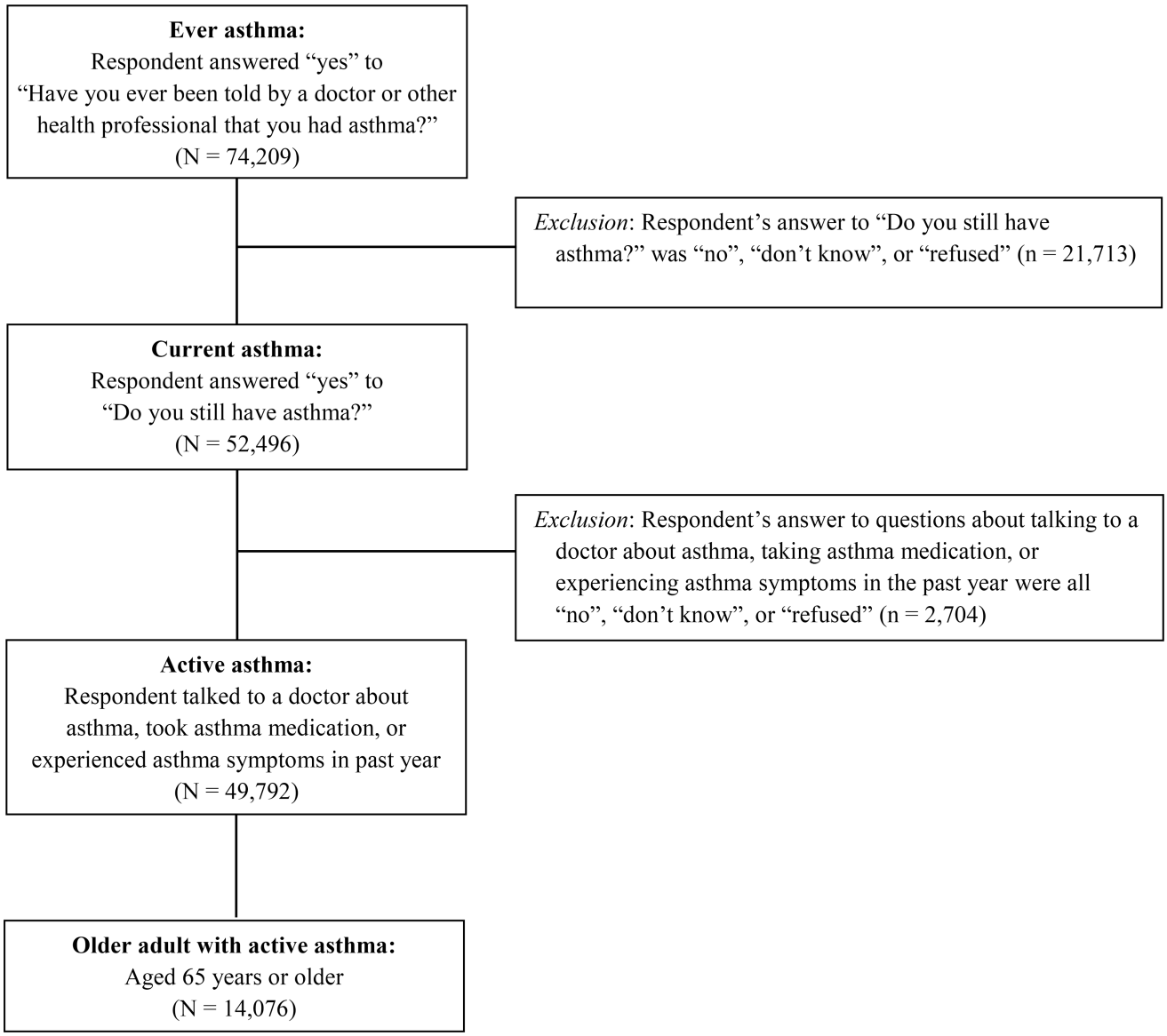

FIGURE 1.

Study Population: Behavioral Risk Factor Surveillance System Asthma Call-Back Survey of Adults (Aged ≥18 Years), 2006–2010

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Table I

Characteristics of Older Adults (Aged ≥65 Years) with Active Asthma by History of Asthma-Related Hospitalizations: Behavioral Risk Factor Surveillance System Asthma Call-Back Survey, 2006–2010

Characteristic	All (N = 14,076[b]) Weighted % (95% CI)	Asthma-Related Hospitalizations[a] None (n = 13,330) Weighted % (95% CI)	≥1 (n = 746) Weighted % (95% CI)	*P*
Demographics				
Census region				.03
Northeast	22.5 (21.2–23.8)	22.4 (21.0–23.7)	24.6 (18.8–30.4)	
Midwest	23.6 (22.5–24.7)	23.6 (22.5–24.7)	23.3 (17.9–28.7)	
South	29.3 (28.0–30.7)	29.2 (27.8–30.6)	31.2 (25.5–36.9)	
West	23.5 (21.1–24.9)	23.8 (22.4–25.3)	18.2 (12.7–23.7)	
Puerto Rico	1.1 (0.8–1.3)	0.9 (0.7–1.2)	_[c]	_[c]	
Household income, annual				<.0001
<$15,000	14.5 (13.3–15.6)	14.0 (12.8–15.2)	22.5 (17.5–27.6)	
$15,000–$24,999	21.8 (20.5–23.1)	21.4 (20.1–22.8)	27.8 (22.1–33.5)	
$25,000–$49,999	27.0 (25.6–28.3)	27.5 (26.1–28.9)	18.1 (12.6–23.7)	
$50,000–$74,999	10.9 (9.9–11.9)	11.1 (10.1–12.1)	_[c]	_[c]	
>$75,000	11.8 (10.6–12.9)	12.0 (10.8–13.2)	_[c]	_[c]	
Unknown	14.1 (13.1–15.2)	14.0 (13.0–15.1)	15.8 (11.1–20.6)	
Race/ethnicity				>0.05
White, non-Hispanic	81.0 (79.5–82.4)	81.3 (79.8–82.8)	75.8 (70.4–81.2)	
Black, non-Hispanic	7.1 (6.2–8.0)	6.9 (6.0–7.8)	10.1 (6.1–14.2)	
Other, non-Hispanic	2.5 (1.8–3.1)	2.5 (1.8–3.2)	_[c]	_[c]	
Multiracial, non-Hispanic	1.8 (1.5–2.1)	1.8 (1.4–2.1)	_[c]	_[c]	
Hispanic	6.6 (5.5–7.7)	6.5 (5.3–7.7)	_[c]	_[c]	
Unknown	1.0 (0.8–1.3)	1.0 (0.7–1.3)	_[c]	_[c]	
Sex				.0003
Male	31.9 (30.4–33.5)	32.5 (30.9–34.1)	21.9 (17.1–26.8)	
Female	68.1 (66.5–69.6)	67.4 (65.9–69.1)	78.1 (73.2–82.9)	

Characteristic	All (N = 14,076[b]) Weighted % (95% CI)	Asthma-Related Hospitalizations[a] None (n = 13,330) Weighted % (95% CI)	≥1 (n = 746) Weighted % (95% CI)	P
Clinical				
Asthma control[d]				<.0001
Well controlled	39.4 (37.8–41.0)	40.8 (39.2–42.4)	16.7 (12.0–21.4)	
Not well controlled	26.7 (25.3–28.1)	26.9 (25.5–28.4)	22.5 (17.1–27.8)	
Very poorly controlled	33.9 (32.4–35.4)	32.3 (30.8–33.8)	60.9 (54.6–67.1)	
Asthma medication use[e]				<.0001
None	23.7 (22.3–25.1)	24.4 (23.0–25.9)	12.0 (7.8–16.3)	
SABA only	18.0 (16.8–19.2)	17.8 (16.5–19.0)	21.9 (16.7–27.2)	
≥1 asthma controller medication[f]	57.3 (55.7–58.9)	56.9 (55.2–58.5)	64.9 (58.7–71.0)	
Oral corticosteroid only[g]	0.9 (0.5–1.3)	0.9 (0.5–1.3)	--[c] --[c]	
Asthma severity[h]				<.0001
Intermittent	46.1 (44.5–47.8)	47.7 (46.0–49.3)	20.9 (15.8–26.0)	
Persistent	53.9 (52.2–55.5)	52.3 (50.7–54.0)	79.1 (74.0–84.2)	
Smoked ≥100 cigarettes ever				.06
Yes	58.2 (56.6–59.8)	57.8 (56.1–59.5)	64.3 (57.9–70.8)	
No	41.8 (40.2–43.4)	42.2 (40.6–43.9)	35.7 (29.2–42.1)	
Time since asthma onset				
<1 year	3.2 (2.6–3.8)	3.1 (2.5–3.7)	--[c] --[c]	.37
1–5 years	12.9 (11.9–14.0)	12.7 (11.7–13.9)	15.6 (10.3–20.9)	
>5 years	83.4 (82.2–84.6)	83.7 (82.5–84.9)	79.6 (73.9–85.4)	
Unknown	0.5 (0.3–0.6)	0.5 (0.3–0.6)	--[c] --[c]	

CI, confidence interval; SABA, short-acting β agonist.

[a] In the past 12 months.

[b] Total study population representative of 2,629,097 adults aged ≥65 years with active asthma in 40 U.S. states, the District of Columbia, and Puerto Rico.

[c] Results based on <50 unweighted respondents or for which the relative standard error was >0.3 were suppressed.

[d] Based on day symptoms, night symptoms, and SABA use in the past 3 months. More information on defining asthma control using ACBS data is available in Zahran HS, et al, "Assessing asthma control and associated risk factors among persons with current asthma - findings from the child and adult Asthma Call-back Survey," *J Asthma*, 2014.[12]

[e] In the past 3 months.

[f] Defined as inhaled corticosteroids, long-acting β agonists, leukotriene modifiers, methylxanthines, cromolyn, nedocromil, or immunomodulators.

[g] Without SABA or asthma controller medication.

[h] Asthma severity not classified for 121 observations because of incomplete information. Asthma severity was measured according to previously published methods consistent with the 2007 National Asthma Education and Prevention Program Guidelines for the Diagnosis and Management of Asthma. Briefly, older adults whose asthma was well controlled without asthma controller medication use in the past three months were categorized as having intermittent asthma. Persistent asthma included all older adults reported to use asthma controller medication (regardless of asthma control status) and those not reported to use asthma controller medication but classified with uncontrolled asthma. More information on defining asthma severity using ACBS data is available in Zahran HS, et al, "Assessing asthma severity among children and adults with current asthma," *J Asthma*, 2014.[13]

Table II

Clinical, Financial, and Environmental Factors Associated with Asthma-Related Hospitalizations Among Older Adults (Aged ≥65 Years) with Active Asthma: Behavioral Risk Factor Surveillance System Asthma Call-Back Survey, 2006–2010

Variable	Asthma-Related Hospitalizations[a] None (n = 13,330) weighted % (95% CI)	≥1 (n = 746) weighted % (95% CI)	Odds Ratio[b] (95% CI)
Clinical comorbidities			
Chronic obstructive pulmonary disease[c]	53.0 (51.3–54.6)	84.8 (80.0–89.5)	4.11 (2.81–6.02)
Coronary artery disease[d]	25.2 (23.7–26.7)	38.9 (32.8–45.0)	1.87 (1.43–2.45)
Depression[e]	26.6 (25.2–28.0)	37.5 (31.2–43.9)	1.42 (1.07–1.90)
Diabetes[f]	23.6 (22.2–25.0)	30.3 (24.3–36.4)	1.43 (1.06–1.93)
Obesity[g]	33.6 (32.1–35.1)	35.8 (29.8–41.8)	1.02 (0.78–1.35)
Cost as a barrier to asthma-related health care			
Unable to see primary care doctor	3.8 (3.2–4.4)	12.8 (7.6–18.0)	3.07 (1.86–5.08)
Unable to see specialist	2.3 (1.8–2.8)	10.1 (5.3–15.0)	3.79 (2.09–6.86)
Unable to buy medication	7.8 (6.9–8.6)	22.5 (16.4–28.5)	2.76 (1.91–3.98)
Home environment			
Secondhand smoke[h]	9.6 (8.6–10.6)	13.7 (8.2–19.3)	1.26 (0.76–2.10)
Pets in bedroom	29.4 (27.9–30.9)	26.1 (21.0–32.5)	0.81 (0.60–1.09)
Cockroaches seen[i]	8.4 (7.6–9.3)	13.9 (9.7–18.0)	1.67 (1.14–2.44)
Mice or rats seen[i]	4.7 (4.0–5.3)	6.1 (2.9–9.4)	1.24 (0.69–2.22)
Mold seen or smelled[i]	6.0 (5.2–6.7)	11.5 (7.6–15.4)	1.71 (1.14–2.57)

CI, confidence interval.

[a] In the past 12 months.

[b] Adjusted for sex, race/ethnicity, annual household income, smoking history, and asthma severity. Reference is older adults with no asthma-related hospitalizations in the past 12 months.

[c] Ever told by a doctor or other health professional that he or she had chronic obstructive pulmonary disease (COPD), emphysema, or chronic bronchitis.

[d] Ever told by a doctor, nurse, or other health professional that he or she had a heart attack, myocardial infarction, angina, or coronary heart disease.

[e] Ever told by a doctor or other health professional that he or she was depressed.

[f] Ever told that he or she had diabetes (not including gestational diabetes, prediabetes, or borderline diabetes).

[g] Body mass index ≥30 kg/m^2.

[h] In the past week.

[i] In the past 30 days.

Table III

Clinical, Financial, and Environmental Factors Associated with Asthma-Related Emergency Department or Urgent Care Center Visits (ED/UCV) Among Older Adults (Aged ≥65 Years) with Active Asthma: Behavioral Risk Factor Surveillance System Asthma Call-Back Survey, 2006–2010

Variable	Asthma-Related ED/UCV[a] None (n = 12,561) weighted % (95% CI)	≥1 (n = 1,515) weighted % (95% CI)	Odds Ratio[b] (95% CI)
Clinical comorbidities			
Chronic obstructive pulmonary disease[c]	52.5 (50.8–54.2)	73.9 (70.0–77.8)	2.26 (1.80–2.83)
Coronary artery disease[d]	24.9 (23.4–26.4)	34.7 (30.4–39.0)	1.53 (1.24–1.89)
Depression[e]	26.2 (24.7–27.6)	36.2 (31.8–40.5)	1.42 (1.15–1.76)
Diabetes[f]	23.5 (22.0–24.9)	28.4 (24.4–32.4)	1.28 (1.03–1.59)
Obesity[g]	33.3 (31.7–34.8)	37.4 (33.1–41.7)	1.13 (0.92–1.38)
Cost as a barrier to asthma-related health care			
Unable to see primary care doctor	3.8 (3.2–4.5)	8.5 (6.2–10.9)	1.92 (1.31–2.81)
Unable to see specialist	2.2 (1.7–2.8)	6.8 (4.4–9.2)	2.47 (1.57–3.90)
Unable to buy medication	7.7 (6.8–8.7)	16.1 (13.0–19.3)	1.87 (1.41–2.46)
Home environment			
Secondhand smoke[h]	9.6 (8.6–10.6)	11.6 (8.3–15.0)	1.10 (0.77–1.57)
Pets in bedroom	39.8 (38.2–41.5)	38.5 (34.2–42.9)	0.88 (0.71–1.09)
Cockroaches seen[i]	8.5 (7.6–9.4)	11.0 (8.5–13.6)	1.23 (0.92–1.65)
Mice or rats seen[i]	4.6 (3.9–5.2)	6.3 (4.1–8.5)	1.30 (0.87–1.95)
Mold seen or smelled[i]	5.8 (5.0–6.6)	10.4 (7.9–13.0)	1.61 (1.18–2.20)

CI, confidence interval; ED/UCV, emergency department or urgent care center visits.

[a] In the past 12 months.

[b] Adjusted for sex, race/ethnicity, annual household income, smoking history, and asthma severity. Reference is older adults with no asthma-related ED or urgent care center visits in the past 12 months.

[c] Ever told by a doctor or other health professional that he or she had chronic obstructive pulmonary disease (COPD), emphysema, or chronic bronchitis.

[d] Ever told by a doctor, nurse, or other health professional that he or she had a heart attack, myocardial infarction, angina, or coronary heart disease.

[e]Ever told by a doctor or other health professional that he or she was depressed.

[f]Ever told that he or she had diabetes (not including gestational diabetes, prediabetes, or borderline diabetes).

[g]Body mass index ≥30 kg/m^2.

[h]In the past week.

[i]In the past 30 days.